



Wonderful Weather (Part 1 of 3):

[Adapted from John Hart's experiments, University of Colorado.]

A teacher demonstration.

What is it?

Earth's atmosphere is divided into numerous layers. At the bottom is the Troposphere, where the majority of our weather takes place. Right above the Troposphere is the Stratosphere. Changes in temperature, pressure, and moisture in either of the Stratosphere or Troposphere have a profound effect on our weather patterns. The Airborne Tropical Tropopause Experiment (ATTREX) flies into the area where the Stratosphere and the Troposphere meet, called the Tropopause, to try to learn more about how these changes effect us here on Earth.

In this teacher demonstration, student will be introduced to convection cells and condensation with a few demonstrations

This activity discusses topics related to National Science Education Standards:

MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

- This activity encourages students to consider the formation of clouds in the atmosphere.

Materials (per class):

Equipment, provided by NASA:

- Convection Cell Kit (which includes lamp, tank with heat plate, Carboy fluid)
- Cloud Chamber Kit (which includes lamp, vacuum chamber, cloud tank, vacuum pump)
- Enough consumable materials (e.g. Carboy fluid) for two demonstrations of each kit listed above

Materials (per student):

Equipment, not provided by NASA:

- Safety Glasses

Printables:

- Introduction to Clouds Worksheet

Artifact included in this kit:

- Scale model of the ATTREX Aircraft and Information Sheet

Recommended Speakers from Ames:

Please note that our Speakers Bureau program is voluntary and we cannot guarantee the availability of any speaker. To request a speaker, please visit <http://speakers.grc.nasa.gov>.

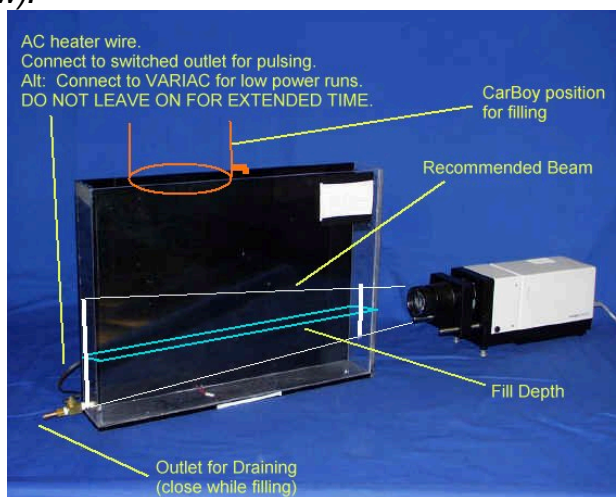
Warren Gore (Atmospheric Sciences)

Dave Jordan (Atmospheric Sciences)

Stephen Dunagan (Atmospheric Sciences)

Set-Up Recommendations:

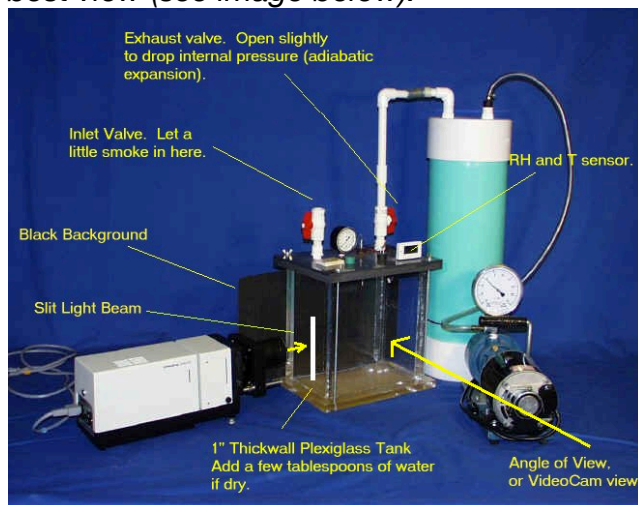
- Prepare copies of **Introduction to Clouds Worksheet** for students
- Set up the two demonstrations at the front of the room:
 - o *Convection Cell Kit:*
 - *First, check to be sure the spout on the side of the tank is closed. Fill the tank with the Carboy fluid by placing the container directly over the tank. You should only need to fill it about 1/3 of the way up (see image below).*
 - *Position the lamp so that it will shine through the side of the tank. You may want to use a slit-slide (or a thick sheet of paper with a slit cut out of the middle) for better viewing. Place the slit-slide (if using) on the side of the tank between it and the lamp (see image below).*



- o *Cloud Chamber Kit:*
 - *Check the level of oil in the vacuum pump before using. It should show in the window at the end.*
 - *Pour a few tablespoons of water into the cloud tank.*
 - *Connect the pump to the plastic vacuum chamber and connect the other side of the chamber to the cloud tank (see image below).*



- *Place the lamp (also possibly with slit slide) next to the tank for the best view (see image below).*



Safety:

- These demonstrations are to be conducted by a teacher or adult only. Please do not let students use any of the components.
- Please have students wear safety glasses during the demonstrations.

Procedure:

1. Introduce the concept of clouds and weather with a class discussion. We know that the Earth is pretty dynamic in a lot of different ways, but one of the ways we notice daily is the weather. Weather consists of different types of atmospheric activity, from temperature to humidity to rain and much, much more. There are a few things that have a very profound effect on the weather: temperature, pressure, and moisture. Our atmosphere is split into layers, with the Troposphere at the bottom near the Earth's surface, the Stratosphere above that, then the Mesosphere, and the Thermosphere. Most of our weather comes from changes in the Troposphere, but we know that there are effects from the area in between the Troposphere and the Stratosphere (called the Tropopause). NASA has actually sent a robotic aircraft, called the ATTREX, to this area of our atmosphere to try to study how this might effect us.
2. Introduce the first demonstration. Students will be able to witness the effects of a convection cell. A convection cell is when a pocket of warm air rises with cooler air around it. We will be using a liquid to demonstrate this effect, but if you could see the air currents, they would move the same way.

3. Pass out the **Introduction to Clouds Worksheet** and ask students to answer question 1.
4. Perform the first demonstration. Give the Carboy liquid a stir before beginning (so that the aluminum pieces are evenly distributed). Turn on the heat plate and lamp. Soon, students should be able to see the pattern of the Carboy fluid moving around in the tank. If needed, have students come up for a closer look. Have students answer question 2 on their **Introduction to Clouds Worksheet**.
5. Perform the second demonstration. Close all of the valves and turn on the pump to evacuate the vacuum chamber. **DO NOT TURN PUMP OFF WITH VACUUM IN HOLDING TANK - RELEASE VACUUM BY OPENING BOTH VALVES BEFORE TURNING PUMP OFF.** After the chamber reaches a pretty low pressure, release the exhaust valve above the cloud tank. This will quickly lower the pressure in the cloud tank, hopefully forming a cloud for a few minutes. Have students answer question 3 and 4 on their **Introduction to Clouds Worksheet**.

Helpful Resources:

NASA Weather:

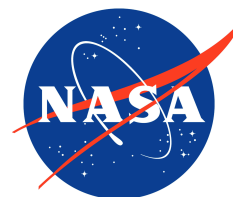
<http://www.nasa.gov/audience/forstudents/k-4/dictionary/Weather.html>

ATTREX:

<http://espo.nasa.gov/missions/attrex/content/ATTREX>

Introduction to Clouds Worksheet

- www.nasa.gov**



Wonderful Weather (Part 2 of 3):

[Adapted from NOAA's *Convection Cell*]

What is it?

Earth's atmosphere is divided into numerous layers. At the bottom is the Troposphere, where the majority of our weather takes place. Right above the Troposphere is the Stratosphere. Changes in temperature, pressure, and moisture in either of the Stratosphere or Troposphere have a profound effect on our weather patterns. The Airborne Tropical Tropopause Experiment (ATTREX) flies into the area where the Stratosphere and the Troposphere meet, called the Tropopause, to try to learn more about how these changes effect us here on Earth.

In this activity, students will experiment with the affects of temperature on weather patterns by creating a convection cell.

This activity discusses topics related to National Science Education Standards:

MS-ESS2-5: *Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.*

- This activity encourages students to consider the formation of clouds in the atmosphere.

Materials (per team of 4 students):

Equipment, provided by NASA:

- Clear Pie Pan

Consumables, provided by NASA:

- Food Coloring

Consumables, not provided by NASA:

- 4-5 3 oz Drink Cups
- Hot water
- Ice water
- Room temperature water

Materials (per student):

Equipment, not provided by NASA:

- Safety Glasses

Printables:

- Convection Cell Worksheet

Artifact included in this kit:

- Scale model of the ATTREX Aircraft and Information Sheet

Recommended Speakers from Ames:

Please note that our Speakers Bureau program is voluntary and we cannot guarantee the availability of any speaker. To request a speaker, please visit <http://speakers.grc.nasa.gov>.

Warren Gore (Atmospheric Sciences)

Dave Jordan (Atmospheric Sciences)

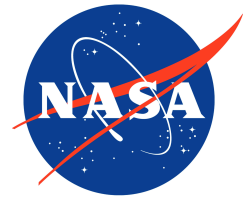
Stephen Dunagan (Atmospheric Sciences)

Set-Up Recommendations:

- Prepare copies of **Convection Cell Worksheet** for students
- Set out supplies for each team

Procedure:

1. Introduce the activity to students with a discussion. How many students have watched a weather report where the reporter was discussing “warm fronts” and “cold fronts”? These are pockets of warm or cold air that are moving around in the atmosphere. Our atmosphere is very sensitive to changes in temperature. Very small changes in degrees can have profound effects on weather patterns. In this experiment, we will learn about *Convection Cells*, which are pockets of warm air surrounded by cold air. Because this warm, moist air is rising, it creates clouds!
2. Split the class into teams (we recommend 4 students to a team). Pass out copies of the **Convection Cell Worksheet**. Have them answer question 1.
3. Explain to students the activity they will be doing. They will create a warm section of water inside of the pie tin. We will pretend that the water in the pie tin is our atmosphere. Using food coloring, we will see how the water moves upward, just like air in our atmosphere!
4. Have students place three of the drinking cups upside down in a triangular shape. Place the pie pan on top and fill it $\frac{3}{4}$ full with room temperature water.
5. Take one of the other drinking cups and fill it with hot water, gently slide that cup underneath the pie pan. Try not to disturb the water inside the pan.
6. Now, fill the eyedropper with a few drops of food coloring. Place the end of the eye-dropper next to the bottom of the pie pan (over the hot water cup) and squeeze out a couple of drops of food coloring.
7. Have students observe what happens for a few minutes and answer question 2 on their **Convection Cell Worksheet**.
8. Now, remove the water from the pie pan and replace with new water. Try the experiment again but placing hot water near the edge of the pan and ice near



the center of the pan. Have students answer questions 3 and 4 on their **Convection Cell Worksheet**.

Helpful Resources:

NASA Weather:

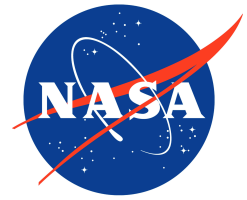
<http://www.nasa.gov/audience/forstudents/k-4/dictionary/Weather.html>

ATTREX:

<http://espo.nasa.gov/missions/attrex/content/ATTREX>

Safety:

- Hot water is hot! Please be sure students use safety with the hot and cold materials.
- Food coloring is non-toxic, but probably not very good to eat.



Name: _____

Convection Cell Worksheet

1. What is a *Convection Cell*?
2. Draw a picture of what you see after adding the food coloring to your pie pan:

| | |
|--|--|
| After 2 Minutes: | After 5 Minutes: |
| | |

3. Draw what you see after adding ice water underneath your pie pan:

| | |
|--|--|
| After 2 Minutes: | After 5 Minutes: |
| | |

4. Did you observe a difference between the two experiments (with and without ice water)? Describe the difference, if any, and why you think it occurred.



Wonderful Weather (Part 3 of 3):

[Adapted from Steve Spangler Science *Cloud in a Bottle*]

What is it?

Earth's atmosphere is divided into numerous layers. At the bottom is the Troposphere, where the majority of our weather takes place. Right above the Troposphere is the Stratosphere. Changes in temperature, pressure, and moisture in either of the Stratosphere or Troposphere have a profound effect on our weather patterns. The Airborne Tropical Tropopause Experiment (ATTREX) flies into the area where the Stratosphere and the Troposphere meet, called the Tropopause, to try to learn more about how these changes effect us here on Earth.

In this activity, students will create a cloud in a bottle using pressure!

This activity discusses topics related to National Science Education Standards:

MS-ESS2-5: *Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.*

- This activity encourages students to consider the formation of clouds as a result of a change in pressure.

Materials (per team of 4 students):

Equipment, provided by NASA:

- Hand pump with Rubber Stopper
- 8-oz Plastic Bottle

Consumables, provided by NASA:

- Rubbing Alcohol

Materials (per student):

Equipment, not provided by NASA:

- Safety Glasses

Printables:

- Cloud in a Bottle Worksheet

Artifact included in this kit:

- Scale model of the ATTREX Aircraft and Information Sheet

Recommended Speakers from Ames:

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Warren Gore (Atmospheric Sciences)

Dave Jordan (Atmospheric Sciences)

Stephen Dunagan (Atmospheric Sciences)

Set-Up Recommendations:

- Prepare copies of **Cloud in a Bottle Worksheet** for students
- Set out supplies for each team

Procedure:

1. Introduce the activity to students with a discussion. When moisture rises up in the atmosphere, it experiences lower and lower pressures, which help condense the moisture into clouds. When the moisture expands, it becomes cooler, allowing the water molecules in the air to stick together more easily. This is how clouds form.
2. Split the class into teams (we recommend 4 students to a team). Pass out copies of the **Cloud in a Bottle Worksheet**. Have them answer question 1.
3. Explain to students the activity they will be doing. Place the rubber stopper on the end of the hand pump. They will create a high-pressure area inside of the bottle using the pump, when that pressure is released, a cloud should form. They will try several times, first with water, then with rubbing alcohol.
4. Have students put a small amount (5 – 10 mL) of water in the bottom of the bottle.
5. Using the rubber stopper, connect the hand pump to the bottle. Be sure to hang onto the rubber stopper!
6. Pump the hand-pump 8-10 times. Then, release the rubber stopper. What happens? Have students answer question 2 on their **Cloud in a Bottle Worksheet**.
7. Have a class discussion about what is happening. Review how when air rises, moisture condenses because of the lower pressure (because of the gas expanding and cooling). So, how did that happen in the bottle? Well, when they pumped with the hand pump, they increased the pressure inside of the bottle, and when they released the cap, they had a rapid reduction in pressure, allowing the condensation process to happen very quickly! Have students answer question 3 on their **Cloud in a Bottle Worksheet**.
8. Now, try the experiment again but with a couple of drops of rubbing alcohol in the bottom of the bottle. Have students answer questions 4 on their **Cloud in a Bottle Worksheet**.



9. Have a class discussion about the differences they saw with the rubbing alcohol vs. water. Why would that happen? What might be different about the rubbing alcohol that would cause the changes they saw in the experiment? (*The rubbing alcohol should create a more impressive cloud because it evaporates, and thus condenses, much more quickly than regular water*). Have students answer question 5 on their **Cloud in a Bottle Worksheet**.

Helpful Resources:

NASA Weather:

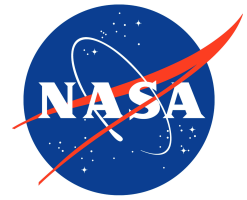
<http://www.nasa.gov/audience/forstudents/k-4/dictionary/Weather.html>

ATTREX:

<http://espo.nasa.gov/missions/attrex/content/ATTREX>

Safety:

- Please be sure students do not consume the rubbing alcohol.
- Please do not allow students to put too much pressure in the bottle (we have recommended number of pumps in the above experiment), as it might pop under extreme pressure.



Name: _____

Cloud in a Bottle Worksheet

1. Why do you think when moisture rises it becomes clouds?
2. Draw a picture of what you see after you popped the rubber stopper with water in the bottle:
3. Why do you think that happened?
4. Now draw a picture of what you saw after using rubbing alcohol:
5. Was it different from you're first experiment? Why or why not?